

APPENDIX 6: PRODUCT ASSURANCE REQUIREMENTS

1 GENERAL

This appendix identifies the Product Assurance (PA) requirements and activities. These requirements apply to the Demonstrator Vehicle and Adapter products and include flight and qualification hardware, software, firmware, and ground support equipment (GSE). The Contractor shall ensure that all subcontractors (if used) adhere to the requirements of this appendix.

1.1 *Product Assurance Management*

The Contractor shall devise a quality system for effective management, control, and audit of their PA program based on the American National Standards Institute (ANSI)/ASQC Q90001-1994 that meets the intent of International Standards Organization (ISO) 9001-1994, "Quality Systems-Model for Quality Assurance in Design, Development, Production, Installation, and Servicing".

1.2 *Reporting and Reviews*

1.2.1 The Contractor shall report the status of all PA tasks through PA Status Reports (PASR's).

1.2.2 The Contractor shall support all reviews required in the SOW by providing the status of all product assurance activities and present any deliverables and/or results required for the review.

2 CONTRACTOR PRODUCT ASSURANCE PLAN

2.1 The Contractor shall prepare, submit, implement, and maintain a Product Assurance Plan (PAP) that complies with the product assurance requirements specified in this SOW.

2.2 The PAP shall include the Contractor's existing internal product assurance practices and procedures to the maximum extent possible.

3 CONFIGURATION MANAGEMENT PLAN

3.1 A Configuration Management (CM) Plan shall be included with the PAP either as an appendix or under separate cover.

3.2 The Contractor's CM Plan shall ensure control of all hardware and software configuration items, documents and drawings, and changes. The plan shall describe the methods of baseline control and change control and approval. The Contractor's CM plan shall be compatible with the X-43C Project CM Plan (X-43C 0100-03) and shall use the Contractor's existing configuration management system to the maximum extent possible.

4 DESIGN ASSURANCE

The Contractor's PAP shall set forth the methods for meeting the design assurance requirements of this section. The Contractor shall provide product assurance participation in all Contractor and X-43C Project Office reviews defined in the SOW. Each review shall include the status of all the product assurance activities and updates to on-going analyses.

4.1 *Fault Tree Analysis*

The Contractor shall deliver quantitative Fault Tree Analyses (FTA) on systems, subsystems, and equipment to track the design effectiveness to support the specified mission reliability and safety requirements. FTA's shall be presented and delivered at each design review.

4.2 *Failure Modes and Effects Analysis*

The Contractor shall deliver a Failure Modes and Effects Analysis (FMEA) which documents the systematic consideration of all likely ways equipment or components (Line or Lowest Replaceable Unit) can fail, single point failures, the causes for each failure mode, and the effects of the failure. FMEA analyses will be delivered and presented at each design review.

4.3 *Reliability*

The overall X-43C Project reliability goal is 80% probability of mission success across all three flights. The Contractor shall develop a reliability program and document results on subsystems and overall system. The Contractor shall evaluate reliability during the design process. The design process should use system reliability as a means of identifying weak points within the system and evaluating whether corrective action can be implemented effectively to increase reliability.

4.4 *Interchangeability*

Flight hardware and spares shall be fully interchangeable among the three DV's and Adapters, both physically and functionally.

5 PARTS AND MATERIAL SELECTION

The Contractor shall propose and implement a Parts and Materials (P&M) program to assure parts and materials meet established requirements. The P&M program shall be implemented during the project design and development phases and continues through the use and maintenance of applicable systems and equipment. All raw materials and components used in the manufacture and assembly of the DV's and Adapters shall have traceability back to the first level suppliers.

5.1 *Nameplates or Product Markings*

All parts and subassemblies shall be marked in a manner with their associated drawing number, part number, and serial number as applicable that does not compromise structural integrity or interfere with the operation of any subsystem/system. The final assemblies shall be marked with a nameplate that contains the assembly drawing number, serial number, and date of assembly.

6 QUALITY ASSURANCE

The Contractor shall establish a Quality Assurance Program that documents and ensures compliance with the requirements for fabrication, assembly, disassembly, integration, testing, handling, preservation, and shipping of the DV and Adapter. The Contractor's method for meeting the requirements of this appendix and any other contractual Quality Assurance (QA) requirements shall be set forth in the PAP. The Contractor shall impose applicable requirements of the PAP upon subcontractors.

6.1 *Fabrication Controls*

Manufacturing shall be accomplished after creating a Fabrication Inspection Plan (FIP) that specifies the activities and creates a signed record of the processes during the manufacturing and in-process inspection activity. Those significant events, such as heat-treating, welding procedures, and surface coating, which could affect safety, performance, or durability, shall have documented evidence of their conduct and adherence to specifications. Fabrication control documents shall define detailed steps for manufacture and assembly, identify Contractor and Government inspection points, specify accept/reject criteria for inspections, and reference applicable process and procedural documents.

Full (100%) inspection of the dimensions necessary to create the assembly shall be conducted and documented as necessary to create a record of those findings after manufacture, assembly, and post machining. Any out of tolerance condition shall be documented and disposition addressed by a Material Review Board comprised of Contractor and NASA representatives.

6.2 *Inspection and Test*

The Contractor shall plan and conduct an inspection and test program that demonstrates that contract, drawing, and specification requirements are met. Inspections and tests shall be performed on products prior to their installation into the next level of assembly. Inspection points shall be defined by the Contractor QA organization for inclusion in the FIP.

6.2.1 Inspection Conditions

Hardware shall be inspected in a temperature and humidity controlled environment of 73 degrees F +/- 5 degrees and below 60% relative humidity. Other inspection that is

necessary to be performed at a temperature outside those limits shall allow time for stabilization from processing or shipping prior to inspection of geometric dimensions.

6.2.2 Inspection Equipment

The inspection of geometric dimensions shall be conducted with either manual tools or automated methods. In either case the equipment shall be of a size that is compatible with the dimension to be verified and is in current calibration status. Visual inspections shall be conducted with the proper optical equipment.

6.3 *Software Quality Assurance*

The Contractor shall adhere to the software quality assurance requirements defined in Appendix 5.

6.4 *Workmanship Standards*

The Contractor shall impose workmanship standards that will assure that the products developed will perform as designed, in the proposed environment, and for the expected mission lifetime. Commercial or NASA workmanship standards guidelines are given in Section 10. Where samples or visual aids showing acceptable workmanship are necessary, the Contractor and the Government will jointly select them.

6.5 *Qualification and Acceptance Testing*

Tests shall be conducted according to documented procedures and verified by the Contractor's Quality Assurance representatives.

6.6 *Contamination/Foreign Object Damage Control*

The Contractor shall develop DV and Adapter contamination/Foreign Object Damage (FOD) requirements, and establish and maintain a contamination/FOD control program consistent with mission requirements and aerospace standards.

6.7 *Failure Reporting*

6.7.1 A documented failure reporting system shall be implemented. A problem/failure report shall be written for any departure from design, performance, testing, or handling requirement that affects the function of flight equipment, or ground support equipment that interfaces with flight equipment, or that could compromise mission objectives. A failure analysis shall be performed on all parts/components that fail after the start of assembly of flight components and subsystems.

6.7.2 Reporting of failures shall begin with the first power application at the box level. This reporting shall continue through formal acceptance of the hardware. For software problems, failure reporting shall begin with the first test use of the software after board-level testing has been completed. The Contractor shall maintain failure-reporting

records of problems encountered at the lower levels of assembly for information.

7 SYSTEM SAFETY

The Contractor shall submit a System Safety Plan as part of the PAP submittal. Contractor documents referenced therein shall also be submitted with the PAP. The System Safety Plan shall be compatible with the X-43C Project Safety Plan 0100-08. The Contractor's industrial safety and health activities shall be in compliance with the Occupational Safety and Health Act of 1970. Safety documentation shall be presented at the reviews defined in this SOW and delivered with the DV and Adapter as part of the End Item Data Package.

8 ENVIRONMENTAL

The Government will complete the Environmental Protection Agency (EPA) Environmental Analysis Checklist. If a need is indicated, an EPA review by LaRC's Office of Environmental Engineering will be initiated to determine the impact the DV, Adapter, and Booster may have on the environment. The Contractor shall provide information necessary for LaRC to complete the review.

9 RISK MANAGEMENT

The Contractor shall prepare a Risk Management Plan describing the principles, processes, and approach for continuous risk management for the DV and Adapter. The Risk Management Plan shall be compatible with the X-43C Risk Management Plan 0100-02. The Contractor shall provide policy and procedures to identify, analyze, plan, track, control, and report risks.

10 APPLICABLE DOCUMENTS

10.1 General Requirements

- NPD 8730.3, NASA Quality Management System Policy (ISO 9000).

10.2 Workmanship Standards

- Foreign Object Damage/Foreign Object Debris (FOD) Prevention, NAS 412, 10/1/1997
- Soldering of Electrical Connections: NASA-STD-8739.3, Soldered Electrical Connections.
- Cabling, Harnessing, and Crimping: NASA-STD-8739.4, Crimping, Interconnecting Cables, Harnesses, and Wiring. Note: MIL -STD-1130B, Connections, Electrical, Solderless Wrapped can be used if the missions are planning to use wire wrap for flight hardware or mission critical ground support equipment.

- Conformal Coating and Staking: NAS 5300.4 (3J-1), Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Electronic Assemblies.
- ESD Control: NASA-STD-8739.7, Electrostatic Discharge Control (Excluding Electrically Initiated Explosive Devices).
- Surface Mount Technology (SMT): NHS 5300.4 (3M), Workmanship Standard for Surface Mount Technology. Note: SMT processes must be qualified to the mission profile and life expectancy of the mission.
- Printed Wiring Board Design: ANSI/IPC-D-275, Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies, Class 3.
- Printed Wiring Board Procurement: IPC 6011 and IPC 6012, Class 3 as the basic specification requirements with GSFC S-312-P-003B, Procurement Specification for Rigid Printed Wiring Boards for Space Applications and other High Reliability Uses as a supplement.
- Fiber Optic: NASA-STD-8739.5, Fiber Optic Terminations, Cable Assemblies, and Installation.